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ABSTRACT

Competencies for production machine shop are provided for the fourth of four topic areas: the milling machine. Each competency appears in a one-page format. It is presented as a goal statement followed by one or more "indicator" statements, which are performance objectives describing an ability that, upon attainment, will establish competency for the stated goal. Indicator statements are further qualified by one or more "benchmark" statements or observable behaviors describing what the trainee will do to prove that he/she is demonstrating achievement of the performance objective. Benchmark statements are followed by an "assessment" statement, which describes how the observer determines that the benchmark is achieved and establishes the criteria for performance. The competencies for this topic are divided into 10 sections: milling machine classifications, holding devices and attachments, milling cutters, milling operations, slab milling, face milling, straddle milling and milling a slot, sawing and gang milling, milling a square on a straddle mill, and vertical milling machine. (YLB)

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Production Machine Shop Employment Competencies Part Four: The Milling Machine

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Los Angeles Unified School District
Manpower Program Development

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Table of Contents

Competencies	Page
Milling Machine Classifications	1
Holding Devices and Attachments	3
Milling Cutters	11
Milling Operations	17
Slab Milling	22
Face Milling	27
Straddle Milling and Milling a Slot	31
Sawing and Gang Milling	34
Milling a Square on a Straddle Mill	38
Vertical Milling Machine	41

PREFACE

The competencies for Production Machine Shop have been developed in four topic areas as follows:

1) Part One: Principles and Practice of Machine Shop
2) Part Two: Saws, Drills, and Grinders
3) Part Three: The Engine Lathe
4) Part Four: The Milling Machine

Each topic has a number of competencies identified. The competencies are presented as a series of goal statements followed by one or more "indicator" statements. An "indicator" is a performance objective describing an ability, which, upon attainment, will establish competency for the stated goal.

Indicator statements are further qualified by a series of "benchmark" statements. A "benchmark" is an observable behavior. Benchmarks describe what the trainee will do to prove that he is demonstrating achievement of the performance objective. Benchmarks are an end result, they do not describe how the trainee learned the behavior, they only state what the behavior is. There may be one or more benchmarks (behaviors) for each indicator statement (performance objective).

Benchmark statements are followed by an "assessment" statement. The assessment statement describes how the observer determines that the benchmark is achieved. Assessment statements establish the criteria for performance. Instructor, class member consensus opinion, or combination of instructor input and trainee input may contribute to the final determination of evaluation criteria. The assessments that are shown provide the basis for performance evaluation for each benchmark.

USE OF THE COMPETENCIES

The integration of the material into course curriculums is dependent on the agency providing JTPA training services. Selection of competencies should be based on participant need and compatibility with the course of instruction. The identification of Production Machine Shop Competencies does not attempt to provide input in regards to teaching methodology. The statements present a consensus opinion of optimum skill level for youth entering the work force in the area of Production Machine Shop.

VALIDATION

The competencies were developed from research and direct experience in the instruction of JTPA participants. Validation of the attached material was achieved through a consensus of instructional staff and employer Advisory Boards. Their collective opinion was formed from research and data, which provided the basis for the selection of Production Machine Shop Competencies.

ACKNOWLEDGEMENTS

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The technical information provided in the attached material has been developed form the course text, General Industrial Machine Shop by Harold V. Johhson, Chas. A. Bennett Co., Inc., Peoria, Ill.

Competencies have been written by Gus Bishart with the assistance of Claire Werner as part of the school district's contract with the City of Los Angeles and the State of California.

Bernardo R. Sandoval, Director
Manpower Program Development
December, 1984

SECTION ONE

MILLING MACHINE CLASSIFICATIONS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various classifications of milling machines.

BENCHMARK: The trainee names the four general classifications of milling machines.

ASSESSMENT: The trainee states the following:

1. Column-and-knee type:
    a. hand miller.
    b. plain milling machine.
    c. universal milling machine.
    d. ram-type universal.
2. Planer milling machine.
3. Fixed-bed manufacturing type.
4. Special types:
    a. rotary table machines.
    b. planetary machines.
    c. duplication.
    d. pantograph.
    e. profiling.
    f. machining center.

SECTION TWO

HOLDING DEVICES AND ATTACHMENTS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee names the three primary holding devices used on the milling machine.

ASSESSMENT: The trainee states the following:

1. Vises.
2. Spindle and Arbor.
3. Clamps.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee identifies and names the most common vises used on the milling machine.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies and names the following:

1. Plain flanged vise.
2. Adjustable swivel vise.
3. Universal swivel vise.
4. Cam-lock vise.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee performs no less than one operation using a vise on the milling machine.

ASSESSMENT: The trainee demonstrates the correct use of a vise on the milling machine. The trainee squares-up the vise with the machine spindle by either of the following methods:

1. Sets the vise at right angles to the spindle by a square placed against the jaws and the column.

2. Fastens a dial indicator to the arbor. With the indicator plunger bearing on the solid vise jaw, the trainee moves the table back and forth longitudinally. Adjusts the vise to give a 0-0 reading from one end of the solid jaw to the other.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee identifies the purpose of the spindle on a milling machine.

ASSESSMENT: The trainee states the following:

The spindle of a milling machine is designed to hold and drive the cutter. This is its purpose whether it is arranged on an arbor, collet, adapter, or other device.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee identifies, names and describes the function of cutter holding devices.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies, names, and describes the following:

1. Arbors: are used to hold and drive milling machine cutters. They are made in many styles and shapes.
2. The Draw-in Bar: is used to draw the arbor into place and to hold it there securely.
3. The Key: the cutter is prevented from slipping on the arbor by a keyway. This is cut the whole length of the arbor.
4. Spacing Collars: are provided for locating the cutter and holding it in position on the arbor.
5. Bearing Sleeve: provides a support for the arbor.
6. Adapters: permits the use of a larger variety of tools and toolholding devices.
7. Collets and Sleeves: cutters are not made with ends to fit directly into the spindle of the machine. A collet is needed to take up the space between the tapered hole in the spindle and the tapered shank of the end mill.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee identifies and names various types of clamps.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies and names the following clamp types:

1. Special clamp.
2. Screw heel clamp.
3. Gooseneck clamp.
4. Plain or flat clamp.
5. U-clamp
6. Single-finger clamp.
7. Double-finger clamp.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of workpiece holding devices and attachments used on milling machines.

BENCHMARK: The trainee identifies five points to consider when clamping workpieces to the milling machine.

ASSESSMENT: The trainee states the following:

1. Make sure that the machine table and the bearing points are clean.

2. The work must be well supported to prevent springing when the vise clamps are tightened.

3. Clamping must be correct. If not, the milled surface will be inaccurate when the clamps are removed. Also, the piece can work loose and damage the workpiece or the cutter. It can injure the operator or damage the machine.

4. Make sure that several different sizes and types of clamps- step blocks, planer jacks, straps, shims, nuts, and bolts- are available.

5. Make sure the clamp is paralled to the table. Be sure the bolt is closer to the workpiece than to the step block. Be sure that the bolt threads are in good condition.

Instructor's approval indicates satisfactory completion.

SECTION THREE

MILLING CUTTERS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of milling cutters.

BENCHMARK: The trainee identifies and names various types of arbor cutters and shank cutters.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies and names the following:

Arbor Cutters

1. Plain Milling
2. Side Milling
3. Staggered Tooth Milling
4. Metal-Slitting Saws
5. Angular Milling Cutters
6. Inserted-Tooth Milling
7. Form-Relieved Cutters

Shank Cutters

1. End Mills
2. Shell End Mills
3. T-Slot Cutters
4. Woodruff Key Seat Cutters
5. Fly Cutters

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of milling cutters.

BENCHMARK: The trainee identifies and names the elements of a milling cutter.

ASSESSMENT: Given a drawing of a milling cutter, the trainee identifies and names the following:

1. Direction of rotation.
2. Tooth face.
3. Cutting edge.
4. Depth.
5. Land.
6. Relief angle.
7. Chip clearance.
8. Clearance angle.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of milling cutters.

BENCHMARK: The trainee identifies elements to consider when determining the correct cutting speed for a milling operation.

ASSESSMENT: The trainee states the following:

1. The material being cut.
2. Cutter material.
3. Use of coolants.
4. Depth of cut.
5. Finish required.
6. Type of cutter.
7. Rate of feed.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies various types of milling cutters.

BENCHMARK: The trainee calculates the cutting speed and the feed rate using the correct formulas.

ASSESSMENT: Given problems to determine the cutting speed and the feed rate for milling operations, the trainee uses the following formulas correctly.

Cutting Speed $CS = \frac{\pi \times DN}{12}$

D = diameter of cutter in inches
N = RPM

Feed $F = R \times T \times RPM$

F = feed rate in inches per minute
R = feed per revolutions of tooth per revolution
T = number of teeth

SECTION FOUR

MILLING OPERATIONS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies milling operations.

BENCHMARK: The trainee reviews the safety precautions to observe when performing milling operations. The trainee states four additional precautions and indicates what could happen if he/she does not adhere to precautions.

ASSESSMENT: The trainee reviews the safety precautions from Part One: Principles and Practices of Production Machine Shop. He/she states these safety precautions to the instructor.

The trainee further emphasizes the following:

1. Always stop the spindle to remove chips around the cutter. Never remove chips while the cutter is on. This will prevent damage to the machine and injury to the operator.

2. If it is necessary to reach over a cutter, first stop the machine. Do not reach over a revolving cutter. Avoid being seriously cut.

3. Securely clamp the workpiece before engaging the cutter. If not, the workpiece can spring loose and cause serious injury.

4. Always use a brush for removing chips from a milling machine. Never use your bare hand. Chips may enter under the skin unnoticed until infection sets in.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies milling operations.

BENCHMARK: The trainee identifies and names the parts on a universal milling machine.

ASSESSMENT: The trainee identifies and names the following parts:

1. Spindle.
2. Overarm.
3. Table.
4. Table swivel location.
5. Vertical feed handcrank.
6. Cross-feed handwheel.
7. Elevation screw.
8. Table traverse handwheel.
9. Outer arbor support.
10. Speed change levers.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies milling operations.

BENCHMARK: The trainee names the two types of milling operations.

ASSESSMENT: The trainee states the following:

1. Peripheral milling.
2. Face milling.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee identifies milling operations.

BENCHMARK: The trainee distinguishes between face milling and peripheral milling.

ASSESSMENT: The trainee states the following:

1. In peripheral milling the workpiece can be fed either with or against the direction of cutter rotation.

2. In face milling, the feeding motion is generally partly with and partly against the direction of cutter rotation.

SECTION FIVE

SLAB MILLING

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform slab milling operations.

BENCHMARK: The trainee sets up workpieces for no less than one milling operation.

ASSESSMENT: The trainee proceeds as follows:

1. Cleans chips and dirt form the surface of the table.
2. Sets the vise at the approximate center of and parallel to the table.
3. Bolts down the vise.
4. Checks with the indicator to see if drawing up the bolts has shifted the vise out of alignment.
5. Opens the vise jaws to receive the workpiece. Measures the depth of the jaws and the height of the workpiece to see if it is necessary to use parallels. Places a piece of paper under each corner of the workpiece. Tests for seating.
6. Tightens the vise jaws. Taps the workpiece lightly to seat it against the parallels. Pulls on pieces of paper to see if work is seated properly.
7. Loosens the saddle clamp and turns the cross-feed handwheel. Moves the saddle as close to the column as possible.
8. Selects a plain milling cutter of the smallest diameter possible to cover the workpiece.
9. Cleans the taper hole in the spindle before mounting the arbor. Cleans the arbor's taper shank of chips and dirt.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform slab milling operations.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

10. When removing the arbor nut, clamps the arbor support in place to prevent springing the arbor. Protects the table with a cloth or board when laying down collars or cutters.

11. Mounts the cutter on the arbor so that end thrust caused by the helix angle of the cutter teeth is against the spindle bearings. Does not drive the cutter on the arbor with a hammer.

12. Keys the cutter to the arbor.

13. Cleans the spacing collars, then slides them on the arbor. Checks to see if the bearing collar is as close to the cutter as possible.

14. Screws the nut on the arbor with the fingers.

15. Moves the overarm into position. Slides the arbor support onto the overarm. Moves it until it is over the bearing sleeve or over the end of the pilot. Locks the overarm in place.

16. Locks the spindle. Tightens the arbor nut with a wrench.

17. Adjusts the table to the proper height for the cut desired. Adjusts the trip dogs for the length of cut to be taken.

18. Calculates RPM for the proper cutting speed required by the given cutter and material.

19. Moves the table longitudinally so that the end of the workpiece is under the cutter.

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform slab milling operations.

BENCHMARK: The trainee performs no less than one cutting operation on the milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Adjusts the machine for the correct spindle speed and feed.
2. Moves the saddle so that the workpiece is central with the cutter. Locks the saddle in position.
3. Moves the table so that the right-hand end of the workpiece is under the cutter.
4. Starts the machine with the cutter revolving in a left-hand direction.
5. Raises the knee until the cutter just touches the workpiece. Stops the machine.
6. Sets the 0 of the graduated dial on the knee to its index line.
7. Moves the cutter back from the workpiece. Raises the knee until the number on the graduated line corresponds to the required number of thousandths of an inch of material to be taken from the workpiece in one cut. If a cut is to be taken from both sides, removes half of the metal from each side.
8. Starts the machine and takes a trail cut. Stops the machine and measures the workpiece.

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform slab milling operations.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

9. Moves the workpiece to the cutter, starts the machine, and completes the cut. When taking the finished cut, does not stop the machine until the entire workpiece surface has been machined.

10. Shuts off the machine when backing up the workpiece. After the cut has been completed, checks the work with a micrometer or steel rule.

Instructor's approval indicates satisfactory completion.

SECTION SIX

FACE MILLING

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the correct procedures for face milling.

BENCHMARK: The trainee identifies the purpose of face milling.

ASSESSMENT: The trainee states the following:

Face milling is the production of a surface that is parallel to the face of the cutter and at right angles to the axis of the cutter.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the correct procedures for face milling.

BENCHMARK: The trainee sets up no less than one face milling operation.

ASSESSMENT: The trainee proceeds as follows:

1. The facing cutter is about 1" larger in diameter than the width of the face to be milled.

2. Mounts the workpiece in the vise, angle plate or fixture. The work is centrally located on the table but overhanging the inside edge about 1". Checks to make sure that the holding device is in the correct alignment.

3. Sets the machine for the correct speed and feed.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the correct procedures for face milling.

BENCHMARK: The trainee performs no less than one cutting operation on the milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Moves the knee until the workpiece is centered on the cutter.
2. Moves the saddle in until the workpiece just clears the face of the cutter. Sets the graduated cross-feed dial at zero, making sure the backlash has been taken out of the screw.
3. Starts the machine. Checks the rotation of the cutter.
4. Turns the cross-feed by hand the correct amount for a roughing cut.
5. Throws in the feed. Checks the cutting action.
6. If needed, makes a finishing cut. Makes sure the work clears the cutter.

Instructor's approval indicates satisfactory completion.

SECTION SEVEN

STRADDLE MILLING AND MILLING A SLOT

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform milling machine functions of straddle milling and milling a slot.

BENCHMARK: The trainee performs no less than one straddle milling operation on the milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Mounts the vise or other holding device on the milling machine table.

2. Places the cutters together hub to hub, then measures the distance between them with a feeler gage. Then mounts the cutters the required distance apart.

3. Subtracts the distance between cutters from the finished size of the workpiece. Mounts a suitable spacer between the cutter hubs.

4. When the cutters have been mounted on the arbor, moves the table so that they are centered over the workpiece.

5. Raises the table. Starts the machine. Feeds the workpiece toward the revolving cutter.

6. Lowers the table. Sets the dial on the traverse feed screw at zero to the index line.

7. Uses the following formula to center the workpiece:

   $B = (D \div A) - 2$

   $F = (D + E) - B$

   A = distance between cuts
   B = width of cut
   D = width of work
   E = width of cutter
   F = distance cutters need to be moved to make two cuts

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform milling machine functions of straddle milling and milling a slot.

BENCHMARK: The trainee performs no less than one operation milling a slot.

ASSESSMENT: The trainee proceeds as follows:

1. Places a staggered-tooth side-milling cutter on the arbor.
2. Fastens the workpiece in the vise.
3. When the workpiece is rectangular, moves the table to locate the work in the proper position. Holds the end of a rule against the inner side of the cutter. Moves the saddle to set the cutter the correct distance from the side of the work.
4. Uses a piece of paper as a feeler between the workpiece and cutter. Starts the machine. Raises the knee until the revolving cutter tears the paper. Makes sure the paper is long enough so that his/her hands clear the revolving cutter.
5. Sets the graduated dial on zero to its index line.
6. Moves the workpiece back from the cutter. Raises the knee to take the correct depth of cut.
7. Starts the machine. Engages the table feed.
8. When cutting a keyway in a round shaft, mounts a staggered-tooth, side-milling cutter on the arbor.
9. Centralizes the cutter.
10. Raises the table to take the proper depth of cut.

SECTION EIGHT

SAWING AND GANG MILLING

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee understands milling machine functions of sawing and gang milling.

BENCHMARK: The trainee performs no less than one sawing operation on the milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Selects a saw of a diameter so that the cutter will allow the arbor to clear the top of the bolts that hold the workpiece to the table.
2. Fastens the workpiece over one of the T-slots of the table with clamps.
3. Mounts the saw on the arbor as close to the column as possible.
4. Backs up the table. Raises the knee to take a cut below the thickness of the workpiece.
5. Starts the machine, throws in the feed, and takes the cut.
6. When sawing a workpiece in the vise, the trainee extends the workpiece beyond the end of the vise.

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee understands milling machine functions of sawing and gang milling.

BENCHMARK: The trainee describes gang milling.

ASSESSMENT: The trainee states the following:

Gang milling consists of machining surfaces in production work by means of two or more cutters mounted on an arbor.

SECTION NINE

MILLING A SQUARE ON A STRADDLE MILL

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to mill a square with a straddle mill.

BENCHMARK: The trainee performs no less than one sawing operation on the milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Sets the dividing head in the vertical position with the chuck mounted on the nose of the spindle.
2. Obtains a pair of side milling cutters of equal diameter.
3. Cleans the hole in the spindle and the shank on the arbor.
4. Places enough collars on the arbor so that the first cutter will be in proper position on the workpiece when the table is fairly close to the column.
5. Selects the proper size collar to fit the space between the two cutters.
6. Places the second cutter on the arbor. Puts on the other collars and nut. Checks to make sure the bearing collar is as close to the cutter as the chuck and workpiece will permit.
7. Sets the mill for the proper speed and feed.
8. Locks the workpiece in the chuck. Raises the table to the proper height.
9. Moves the workpiece over until the edge of the left-hand cutter nearly touches the workpiece. Locks the knee.
10. Places a 0.010" feeler between the workpiece and the cutter until they grip it lightly.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to mill a square with a straddle mill.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

11. Sets the graduated dial at zero and removes the feeler.

12. Moves the workpiece clear of the cutter.

13. Moves the workpiece from the setting position "A" to the cutting position "B".

14. $\frac{D - F}{2}$ = The width of the cut.

    D = diameter of workpiece
    F = distance between milled surfaces.

15. Moves the workpiece into the cutter by hand feed. Takes a small cut and checks with the micrometer.

16. Checks the workpiece to see if it is centrally located.

17. Engages the feed and completes the cut.

18. Unlocks the dividing head spindle. Releases the plunger pin and turns the rapid indexing plate with spindle attached one-quarter turn.

19. Locks the spindle. Takes the second cut.

SECTION TEN

VERTICAL MILLING MACHINE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform milling operations on a vertical milling machine.

BENCHMARK: The trainee performs no less than one vertical milling operation.

ASSESSMENT: The trainee machines a flat surface as follows:

1. Selects the proper size cutter for the job.
2. Inserts the cutter in the spindle. Tightens the drawbar at the top of the spindle.
3. Lines up the spindle at right angles to the table.
4. Fastens the vise parallel to the T-slots of the table.
5. Mounts the workpiece in the vise or clamps it to the table.
6. Adjusts the machine for the correct speed and feed. Checks the length of the cut to be taken. Adjusts the trip dogs.
7. Moves the workpiece under the cutter. Starts the machine.
8. Raises the knee until the cutter touches the workpiece.
9. Sets the micrometer dial to the 0 on the index line.
10. Moves the table so that the workpiece clears the cutter. Raises the knee the desired height.
11. Moves the table by hand until the cut is started.
12. After the cut has been taken, measures the workpiece.
13. Takes a second cut, if necessary.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to machine metal using a milling machine.

INDICATOR: The trainee demonstrates the ability to perform milling operations on a vertical milling machine.

BENCHMARK: The trainee machines an angel on a surface using a vertical milling machine.

ASSESSMENT: The trainee proceeds as follows:

1. Places layout lines on the workpiece to locate a taper, chamfer or bevel.
2. Mounts the vise on the table in the proper position for machining the job to be done.
3. Swivels the head to the correct angle, depending upon the angle to be machined.
4. Inserts the proper cutter in the spindle.
5. Moves the table into position and takes a trial cut.
6. Continues cutting until the layout lines are reached.